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Potato Experiments, 1892-93, conducted at Khed, Poona District.

1. The aims of the experiments this year were:—

(*a*) To obtain knowledge as to the manner in which the "ring" disease gains admission to the plant.

(*b*) To test the effect of sulphate of copper, caustic lime and soot on disease-germs harbouring in the soil.

(*c*) To test improved methods of cultivation, and in particular to compare the ridge and furrow system of planting with the native "bed" system; also to compare whole potatoes as sets with cut sets.

(*d*) To ascertain whether robust varieties of imported seed will produce healthy crops on diseased land, with or without the treatment noted in (*b*).

(*e*) To compare the values of different varieties of imported seed.

2. The field selected for experiment is fairly deep medium black soil in the heart of the Poona potato district and is of the best kind for potato cultivation. Diseased crops of potatoes have been grown on the land for four years certainly. It is naturally sub-divided into four sections, each being of a slightly different elevation, but each block is tolerably level and all are well suited for irrigation. A well in a central position commands the whole and the water (which is extremely hard) was sufficient in quantity.

3. I append four tabular statements marked Section I, II, III, IV. Each exhibits a distinct line of experiment, and results on each are shown in tabular form as far as possible.

4. It may be useful to note first the manner of preliminary cultivation for the whole crop. The field grew "bajri" (*Penicillaria spicata*) as a rain crop, and as soon as this was reaped and removed our operations commenced. Farm-yard manure, thoroughly decayed and of good quality, was applied to Sections I and II before ploughing. These two sections were ploughed and harrowed three times and clods where necessary were broken by hand, thus securing thorough incorporation of the manure with the soil and thorough tilth to a depth of six inches. To Section III caustic lime was applied after twice ploughing and harrowing; subsequently it was once ploughed and twice harrowed, the object being to secure good tilth and at the same time to mix the lime thoroughly through the upper stratum of soil. Section IV was three times ploughed and harrowed. To this section soot was applied (as to part of Section III) before the sets were planted.

5. The mode of application of the sulphate of copper may be now described. The salt was first converted into a concentrated solution and was then added to the irrigation water as it was raised from the well by môt, a measured quantity of the solution being added to each bagful of well water as it was discharged into the receiving trough at the lip of the well. The salt was thus applied at any desired rate per acre. The hardness of the well water is probably due to corbonate of lime, and it was noticed that when the copper sulphate solution was added, a dense precipitate formed which was carried to the field by the flow of the water. This precipitate was probably hydrated oxide of copper, a compound which destroys fungoid germs but is harmless to vegetable tissue. If this assumption is correct, the change in the constitution of liquid was advantageous, as sulphate of copper has an injurious effect on vegetation.

6. The soot was broadcasted in the furrows immediately before planting, and therefore was in direct contact with the sets. Soot has some manurial value, and has often been used as an insecticide.

7. Turning to the results of the experiments in each plot, in Section I three

varieties of Kumaun potatoes and one kind of local indigenous seed were grown for comparison. The Kumaun potatoes are the descendants of well known English varieties which have been grown for a few years in the hills; but the varieties have become much mixed and are now by no means true to sort. There are eight plots in the section, six of which were treated with sulphate of copper (84 lbs. per acre); two were not so treated. The results in the first three plots are most interesting. Plot A grew country seed, undoubtedly diseased, planted in the native way in beds. Plot B grew Kumaun potatoes planted in the same way. Both these plots were without treatment. The same native seed as in A was planted on the ridge and furrow system in plot C, which was treated with sulphate of copper. About the 1st of January disease made its appearance in Plot A. On the 20th of January it had made considerable progress, at least ¼ of the plants being withered. On this date 1 plant was found diseased in Plot B and 6 plants in Plot C. The disease gradually increased in A and the infection extended into B, being worst in the latter plot along the border line. The disease made little progress in Plot C, and on this plot the benefit of planting the sets wide apart was well marked. The plants were large and vigorous and many flowered. Of these not a few produced seed-plums, a circumstance which has never occurred of late years in this district, though formerly common. While the seed rate was less, the produce was much more than in Plot A, and owing to their size the tubers commanded Rs. 2 per "pulla" (280 lbs.) more in the Poona bazaar than those grown in A. The sulphate of copper, therefore, undoubtedly exercised a beneficial effect upon the disease, but as regards the weight of the produce and the vigorous growth of the tubers, I assign the chief influence to the ridge and furrow system, an incident of which is that it gives ample room to each plant.

8. Plots D and E of Section I may further be compared with advantage.

In both Kumaun "kidneys" were planted on the ridge and furrow system,—cut sets in one plot, whole small potatoes in the other. The results are as under:—

		Seed rate per Acre. Lbs.	Out-turn per Acre. Lbs.
Plot D cut sets	...	1,568	10,065
„ E whole sets	...	1,437	13,509

Wherever diseased seed was planted, sulphate of copper seems to have had some beneficial effect, but where the seed was sound, neither this nor lime nor soot can be said with any certainty to have proved of use. Apparently, the newly imported English seed and the Kumaun-grown English varieties resisted the disease independently of treatment, at any rate to a very large extent. This year, although I watched closely, there was in these varieties no sign of the disease before harvest, but when the crops were lifted, an occasional tuber of all varieties was found diseased.

9. Section II gives results in one respect which I did not anticipate. Sutton's "Early Regent" planted in beds gave a better crop than Sutton's "Windsor Castle" planted in furrows, and as these varieties grown in other plots under like conditions gave nearly like returns, the test is fairly conclusive. The "Early Regent" had a slight advantage of soil and was very even in germination, but these advantages are not sufficient to account for larger out-turn of nearly 6,000 lbs. per acre. The inference need not be that an increased out-turn is got by growing in beds; the safer inference is that if sufficient space is allowed between sets, the bed system does very well, and under these conditions may produce larger tubers and more of them than the ridge system, owing to the better storage of moisture. On the other hand, the luxuriant growth so induced may be the exciting cause of the disease which we are now endeavouring to cope with. The potato naturally likes a sunny well drained situation, and the altered conditions mentioned must have a serious effect on the constitution of the plant.

10. It may be noted here that a cultivator grew some Carter's "Reading

Giant" potatoes from seed supplied by me immediately adjoining Plot B of Section II, which was treated with sulphate of copper. His cultivation was otherwise identical, and as far as I could see, there was no sign of disease in the produce. This looks as if the robustness of the seed was the chief factor in resistance to the disease.

11. Sections III and IV were intended more especially to test the protective value of caustic lime and soot,—each alone or both together, but, as already pointed out, the experiment has so far been inconclusive.

12. In each of these two sections seven varieties of English potatoes from Sutton and Sons were compared. Unfortunately the results were to some extent vitiated by damage to the sets by white ants. The ants were attracted to the field probably by the castor cake which we had to use, as farm-yard manure could not be obtained except at a prohibitive price.

13. The best variety tried, for general cultivation, is Sutton's "Early Regent," which could have been sold in any quantity for seed purposes. Sutton's "Windsor Castle" comes next. Sutton's "Triumph" and Sutton's "Perfection" have each succeeded admirably and are beautifully-shaped varieties which cook well. Cultivators in this part of the country prefer a round potato to an oblong one, and round potatoes command a higher rate in the market. This is a prejudice which it may not be difficult to overcome, but the point is only of importance because it is desirable to meet the raiyat's views as far as possible. Excepting the "White Kidney" and "Snow-drop," both of which are delicate varieties, all crops from Sutton's seed sold readily as seed to cultivators at Rs. 12 per *palla* of 280 lbs. The present bazaar rate for indigenous sorts is Rs. 5 to Rs. 6. Of the Kumaun potatoes the "Magnum Bonums" are preferred.

14. I made a "Crop Experiment" test of a full average crop as grown this year by the cultivators of the Khed taluka. The seed rate, outturn, and value per acre are noted below, and, for comparison, the best returns from the experimental field from English seed similarly tabulated :—

	Seed Rate per Acre. Lbs.	Out-turn per Acre. Lbs.	Value per acre. Rs. A. P.
Cultivator's crop	1,120	10,230	200 15 0
Sutton's Early Regent	1,180	16,871	723 0 0
Sutton's Windsor Castle	1,361	14,365	612 1 0

The great difference in value between our crop and that of the raiyats is due to the higher selling rate (Rs. 12 per palla as against Rs. 5½) which the produce of the English seed has commanded.

SECTION I.

Area 27·82 guntás.

SULPHATE OF COPPER .. 84 lbs. per acre applied dissolved in irrigation water at first time of watering to all plots except A and B.

MANURE .. .. Farm-yard manure 20 cubic yards per acre applied before 1st ploughing in October 1892. 1¼ cwt. per acre of saltpetre to all plots as a top-dressing on 5th January 1893.

A.	B.	C.	D.	E.	F.	G.	H.
Area 4·53 guntás.	Area 1·02 guntás.	Area 3·47 guntás.	Area 1·53 guntás.	Area 1·67 guntás.	Area 6·07 guntás.	Area 0·93 guntás.	Area 8·64 guntás.
Variety, Local seed.	Variety, Kumaun Kidney.	Variety Local seed same as A.	Variety, Kumaun Kidney.	Variety, Kumaun Kidney.	Variety, Kumaun "Magnum Bonum."	Variety, Kumaun "Magnum Bonum."	Variety, Kumaun "White Elephant."
Planted 24th November 1892 in the country way.*	Planted 24th November 1892 like A.	Planted † ridge and furrow system on 24th November 1892.	Cut sets planted ridge and furrow system, 24th November 1892.	Whole small potatoes as sets planted ridge and furrow system, 24th November 1892.	Cut sets planted ridge and furrow system, 25th November 1892.	Small potatoes planted whole on 25th November 1892.	Cut sets planted ridge and furrow system, 25th November 1892.
Harvested, 13th and 14th February 1893.	Harvested, 14th March 1893.	Harvested, 2nd March 1893.	Harvested, 14th March 1893.	Harvested, 14th March 1893.	Harvested, 15th March 1893.	Harvested, 15th March 1893.	Crop harvested on 1st and 2nd March 1893.
Seed ... { Plot ... 187 lbs. / Acre ... 1,655	Seed ... { Plot ... 60 lbs. / Acre ... 2,352	Seed ... { Plot ... 93 lbs. / Acre ... 1,118	Seed ... { Plot ... 60 lbs. / Acre ... 1,568	Seed ... { Plot ... 60 lbs. / Acre . 1,437	Seed ... { Plot ... 170 lbs. / Acre ... 1,120	Seed ... { Plot ... 32 lbs. / Acre . 1,306	Seed ... { Plot ... 562 lbs. / Acre ... 1,675
Outturn. { Plot ... { Saleable. 741 lbs. / Unsaleable. 45 / Acre ... { Saleable. 6,543 / Unsaleable 397	Outturn. { Plot ... 293 lbs. / Acre ... 11,490	Outturn. { Plot ... 1,083 lbs. / Acre ... 12,484	Outturn. { Plot ... 385 lbs. / Acre ... 10,065	Outturn. { Plot ... 564 lbs. / Acre ... 13,509	Outturn. { Plot ... 1,795 lbs. / Acre ... 11,828	Outturn. { Plot ... 254 lbs. / Acre ... 10,367	Outturn. { Plot ... 2,325 lbs. / Acre ... 10,763
Very badly diseased.	Slightly diseased.	Slightly diseased.	Uneven: some cut sets rotted.			Damaged by water channel.	

* "*Country way*".—The cut sets were planted in the furrow behind an ordinary country plough. The soil moved in making the next furrow covered the sets. Subsequently long narrow beds were formed, each containing four rows of potatoes. The rows were about 9 or 10 inches apart and the sets were 6 inches to 8 inches from each other in the rows.

† "*Ridge and furrow*" *System*.—Ridges were drawn with an ordinary country plough about 24 inches apart. The sets were planted 10 inches to 12 inches apart in the furrows. The sets were covered by splitting the ridge intermediate between two furrows, but every 2nd ridge was left intact, thus forming long narrow beds containing 2 rows of potatoes. These beds were found convenient for watering until the potatoes were well above ground. When the plants stood 6 inches high they were earthed up by hand so that they grew in the ridges, the irrigation water now flowing along the furrows. The 2nd earthing up was given with the "Planet Jr." bullock hoe a fortnight after the first (a country plough would have done the work)

Plot A was irrigated eleven times only, watering having to be stopped on account of the disease.

Plot H was watered twelve times, being an early variety.

All other plots were watered thirteen times.

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SECTION II. Area 24·18 guntás. Plot A, planted 1st December 1829
Plot B, planted 2nd December 1892.

SULPHATE OF COPPER ... { 50 lbs. per acre applied dissolved in first irrigation water (December 1st and 2nd, 1892).
40 lbs. per acre applied similarly in water given on 6th January 1893.

MANURE ... ... { Farm-yard manure—20 cubic yards per acre—applied before 1st ploughing in October 1892.
1½ cwt. saltpetre per acre as top-dressing on 5th January 1893.

A.

Area 13·04 guntás

Variety—Sutton's "Early Regent."

Planted in beds, two rows in each bed.

2 feet between rows; 10 inches to 12 inches between sets.

			lbs.
Seed ...	Plot	...	384½
	Acre	...	1,180
Out-turn ...	Plot	...	5,501
	Acre	...	16,871

Harvested, 14th and 15th March 1893.

B.

Area 11·14 guntás.

Variety—Sutton's "Windsor Castle."

Planted ridge and furrow system. Same distance between rows and sets as in A.

			lbs.
Seed ...	Plot ...	...	379
	Acre	...	1,361
Out-turn ...	Plot ...	...	3,054
	Acre	...	10,965

Harvested, 11th and 12th March 1893.

Note.—Germination of plot B slightly uneven: that of A more regular.
Soil of part of plot B not quite so good as plot A.
Irrigated twelve times. Irrigation stopped three weeks before harvest (to ensure the crop being lifted in a clean condition).

SECTION III.

Area 18·22 guntás. Planted with 7 varieties English seed from *Sutton and Sons.*

Planted 30th November 1892. Harvested 13th and 14th March 1893.

Fresh Burnt Lime applied in October, 4 tons per acre.

MANURE.—Whole section received castor-cake, 5 cwt. per acre at time of planting. Plots A to G had a top-dressing of saltpetre 2½ cwt. per acre on 4th January 1893.

Plots A (1) to G (1) received 2 bushels soot per gunta at time of planting. Plots A (1) to G (1) do 1½ do do

A.	B	C	D	E	F	G	A (1)	B(1)	C(1)	D(1)	E(1)	F(1)	G(1)
Area. 1·34 guntas.	Area. 1·3 guntas.	Area. 1·28 guntas.	Area. 1·2 guntas.	Area. 1·21 guntas.	Area. 1·19 guntas.	Area. 1·20 guntas.	Area. 1·36 guntas.	Area. 1·37 guntas.	Area. 1·38 guntas.	Area. 1·34 guntas.	Area. 1·35 guntas.	Area. 1·34 guntas.	Area. 1·36 guntas.
Variety, "Perfection."	Variety, "Satisfaction."	Variety, "Snow-drop."	Variety, "Triumph."	Variety, "White Kidney."	Variety, "Windsor Castle."	Variety, "Early Regent."	Variety, "Early Regent."	Variety, "Windsor Castle."	Variety, "White Kidney."	Variety, "Triumph."	Variety, "Snow-drop."	Variety, "Satisfaction."	Variety, "Perfection."
Seed. lbs. Plot ... 55 Acre ...1,650	Seed. lbs. Plot ... 45½ Acre ...1,411	Seed. lbs. Plot ... 49½ Acre ...1,547	Seed. lbs. Plot ... 51 Acre ...1,706	Seed. lbs. Plot ... 42 Acre...1,476	Seed. lbs. Plot ... 40½ Acre... 1,361	Seed. lbs. Plot ... 35 Acre...1,180	Seed. lbs. Plot ... 40 Acre ...1,180	Seed. lbs. Plot ... 46½ Acre ...1,361	Seed. lbs. Plot ... 51 Acre ...1,476	Seed. lbs. Plot ... 57 Acre...1,706	Seed. lbs. Plot ... 52 Acre...1,547	Seed. lbs. Plot ... 47½ Acre...1,411	Seed. lbs. Plot ... 56 Acre...1,650
Out-turn. lbs. Plot ... 392 Acre... 11,701	Out-turn. lbs. Plot ... 362 Acre...11,138	Out-turn. lbs. Plot ... 358 Acre ...11,187	Out-turn. lbs. Plot ... 369 Acre ...12,300	Out-turn. lbs. Plot... 308 Acre. 10,181	Out-turn. lbs. Plot... 385 Acre 12,941	Out-turn. lbs. Plot... 426 Acre. 14,200	Out-turn. lbs. Plot ... 482 Acre ...14,176	Out-turn. lbs. Plot ... 492 Acre ..14,335	Out-turn. lbs. Plot... 220 Acre...6,376	Out-turn. lbs. Plot .. 352 Acre. 10,507	Out-turn. lbs. Plot... 319 Acre. 9,600	Out-turn. lbs. Plot... 294 Acre. 8,776	Out-turn. lbs. Plot ... 244 Acre...7,176

Note.—Cut potatoes used as "sets" throughout; planted ridge and furrow system.
Bridges about 2 feet apart. Sets 10 inches to 12 inches distant from each other in the rows.
Irrigation water applied 12 times. Irrigation stopped three weeks before harvest.
Plots C (1), E (1) and G (1) were seriously damaged by white ants. Plots D (1) and F (1) were also damaged, but to a less extent. The ants ate the sets before germination.

SECTION IV.

Area 19·55 guntas.

Planted with 7 varieties English seed from *Sutton & Sons.*

Planted 30th November and 1st December 1892.

Harvested, 13th and 14th March 1893.

SOOT.—30 *bushels to the whole section applied in the furrows at time of planting.*

MANURE .. { Plots A to G a top-dressing of 2½ cwt. saltpetre per acre on 5th January 1893.

Plots A (1) to G (1) at time of planting 5 cwt. per acre castor cake and a top-dressing of saltpetre 1¼ cwt. per acre on 5th January 1893.

A.	B.	C.	D.	E.	F.	G.	A (1).	B (1).	C (1).	D (1).	E (1).	F (1).	G (1).
Area. 1·31 guntas.	Area. 1·35 guntas.	Area. 1·42 guntas.	Area. 1·14 guntas.	Area. 1·31 guntas.	Area. 1·25 guntas.	Area. 1·33 guntas.	Area. 1·42 guntas.	Area. 1·58 guntas.	Area. 1·54 guntas.	Area. 1·37 guntas.	Area. 1·47 guntas.	Area. 1·51 guntas.	Area. 1·35 guntas.
Variety, "Perfection."	Variety, "Satisfaction."	Variety, "Snow-drop."	Variety, "Triumph."	Variety, White Kidney."	Variety, "Windsor Castle."	Variety, "Early Regent."	Variety, "Perfection."	Variety, "Satisfaction."	Variety, "Snow-drop."	Variety, "Triumph."	Variety, "White Kidney."	Variety, "Windsor Castle."	Variety, "Early Regent."
Seed. Plot ... 54 lbs. Acre ...1,650	Seed. Plot ... 47½ lbs. Acre ...1,411	Seed. Plot ... 54 lbs. Acre ... 1,547	Seed. Plot ... 48½ lbs. Acre ...1,706	Seed. Plot ... 48 lbs. Acre 1,476	Seed. Plot ... 42½ lbs. Acre...1,361	Seed. Plot ... 39 lbs. Acre...1,180	Seed. Plot ... 58½ lbs. Acre...1,650	Seed. Plot ... 55¾ lbs. Acre...1,411	Seed. Plot ... 59¼ lbs. Acre...1,547	Seed. Plot ...66¾ lbs. Acre 1,706	Seed. Plot .... 54 lbs. Acre...1,476	Seed. Plot ... 50 lbs. Acre. 1,261	Seed. Plot .. 39½ lbs. Acre. I.
Out-turn. Plot ... 304 lbs. Acre .. 9,282	Out-turn. Plot ... 300 lbs. Acre... 8,888	Out-turn. Plot ... 356 lbs. Acre. 10,028	Out-turn. Plot ... 274 lbs. Acre .. 9,614	Out-turn. Plot... 294 lbs. Acre.8,977	Out-turn. Plot .. 324 lbs. Acre.10,368	Out-turn. Plot .. 260 lbs. Acre.10,927	Out-turn. t . 409 lbs. Acre.11,521	Out-turn. Plot .. 366 lbs. Acre. 9,265	Out-turn. Plot.. 340 lbs. Acre.8,631	Out-turn. Plot... 348 lbs. Acre.3,860	Out-turn. Plot , 278 lbs. Acre. 7,564	Out-turn. Plot... 348 lbs. Acre. 9,086	Out-turn. Plot .. 277 lbs. Acre. 8,200

Note.—Cut potatoes used as sets—planted ridge and furrow system. Ridges about 2 feet apart, sets 10 inches to 12 inches apart in the rows. Irrigation water applied twelve times. Irrigation stopped three weeks before harvest. Plots C(1), D(1), E(1), F(1), and G(1), damaged by white ants as described under Section III.